CUSTOMER NUMBER **25268**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Wang et al.	Attorney Docket No: UNIV0185
Serial No:	10/655,482	Group Art Unit: 3737
Filed:	September 4, 2003	Examiner: Shahrestani, Nasir
Title:	INTEGRATED OPTICAL SCANNING IMAGE ACQUISITION AND DISPLAY	

APPEAL BRIEF TRANSMITTAL LETTER

Bellevue, Washington 98004

May 2, 2008

TO THE COMMISSIONER FOR PATENTS:

Enclosed herewith for filing in the above-identified patent application is an Appeal Brief. The required fee in the amount of $255 will be paid by credit card during electronic submission. Please charge any additional fees or credit any overpayment to Deposit Account No. 01-1940.

Respectfully submitted,

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APPEAL BRIEF

Bellevue, Washington 98004
May 2, 2008

TO THE DIRECTOR OF THE PATENT AND TRADEMARK OFFICE:

This is an appeal from a final rejection by Examiner Nasir Shahrestani of Group Art Unit 3737. A Final Rejection was mailed on January 10, 2008. Appellants filed a timely Notice of Appeal on March 10, 2008.

The jurisdiction of this board is invoked under the provisions of 35 U.S.C. § 134, 37 C.F.R. § 1.191, and 37 C.F.R. § 41.37(c).

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REAL PARTY IN INTEREST

The real party in interest in this appeal is hereby identified as the University of Washington, since all right and title in the invention and in the patent application on appeal has been assigned to the University of Washington, as evidenced by a chain of title from the inventors in the patent application identified above to the current assignee, as shown below.

1. An assignment of all rights and title in the present patent application was made by inventors **Wei-Chih Wang** (assignment executed on October 2, 2003), **Eric J. Seibel** (assignment executed on October 2, 2003), **Per G. Reinhall** (assignment executed on December 12, 2003), **Mark E. Fauver** (assignment executed on October 2, 2003), and **Chris J. Brown** (assignment executed on January 14, 2004) to the **University of Washington**. The assignments were recorded in the U.S. Patent and Trademark Office on January 28, 2004 at Reel 014938, Frame 0152, on January 28, 2004 at Reel 014938, Frame 0128, on January 28, 2004 at Reel 014938, Frame 0166, on January 28, 2004 at Reel 014938, Frame 0136, and on January 28, 2004 at Reel 014938, Frame 0154, respectively.

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RELATED APPEALS AND INTERFERENCES

No other appeals or interferences are known to appellants, appellants' undersigned legal representative, or by the assignee of this application that will directly affect or be directly affected by or have a bearing on the Board's decision in this pending appeal.

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STATUS OF THE CLAIMS

Claims 1-8, 10-36, and 38-58 remain pending in the application on appeal. No claims have been allowed. Claims 9 and 37 have been canceled, Claims 1-5, 8, 10-19 have been rejected under 35 U.S.C. § 102, and Claims 6, 7, 20-36, and 38-58 have been rejected under 35 U.S.C. § 103. Appellants hereby appeal all of these rejections.

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STATUS OF THE AMENDMENTS

No amendment has been filed subsequent to the final rejection of this application mailed on January 10, 2008.

A copy of the claims on appeal, including all amendments actually entered, is appended hereto.

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SUMMARY OF CLAIMED SUBJECT MATTER

Independent Claim 1

According to a first aspect of the invention, an apparatus (e.g., scanner system 201 of FIGURE 4 or cantilevered laser diode system 270 of FIGURE 6B) is provided for display of an image (scanner system 201 generates an image on display surface 191, see page 18, lines 27-28 or for a hybrid embodiment, see page 20, line 10), in regard to a limited region of interest (e.g., target 190 of FIGURE 3 or FIGURE 5). The apparatus includes a light source (e.g., light source 208 of FIGURE 5 or laser diode 272 of FIGURE 6B), which emits light and a substrate (e.g., N-TYPE SUBSTRATE of FIGURE 5) that serves as a support. The apparatus also includes a cantilever (e.g., cantilever 212 of FIGURE 4 or FIGURE 6B) comprising a fixed end (e.g., fixed end 214 of FIGURE 4) and a free end (e.g., free end 216 of FIGURE 4). The fixed end remains fixed to the substrate, and the free end (e.g., free end 216 of FIGURE 4) extends freely relative to the substrate, enabling the free end to bend and deflect (e.g., when driven into resonance, see page 18, line 9) in regard to the limited region of interest. The bending of the cantilever scans light onto an image plane to create an image (e.g., generating an image, see page 18, lines 27-28). The cantilever is configured as one of a waveguide (see page 19, line 3, cantilever 212 acts as a waveguide) that conveys light from the light source within the cantilever, when scanning the light onto the image plane to create the image, and a moving carrier (e.g., cantilever 212 provides electrical connections to laser diode 272 of FIGURE 6B) for a light source (e.g., laser diode 272 of FIGURE 6B) that emits the light. The light source is mounted on the free end of the cantilever and moves when scanning the light emitted by the light source onto the image plane to create the image. The apparatus further comprises an actuator (e.g., vertical actuator 230 of FIGURE 4) disposed adjacent to the cantilever that is employed for deflecting the cantilever so as to move the free end to scan in a desired motion. The apparatus includes a photon detector (e.g., photon detectors 224a and 224b of FIGURE 3) configured to receive light at a location that is proximate to the cantilever and to the support. Also included is a position sensor (e.g., position sensor array 236 of FIGURE 3) employed for detecting a position of the free end of the cantilever, for producing a signal used in controlling the actuator to cause the cantilever to move in the desired motion.

Dependent Claim 8

Another aspect of the invention is directed to a cantilever that is formed by at least one of: a deep reactive ion etching, a photolithography, an e-beam lithography, and a wet anisotropic etching

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of the substrate using a mask to define a shape of the cantilever (see page 23, lines 2-13, and claims as originally filed).

Independent Claim 20

According to another aspect of the invention, an apparatus is provided for use either for a far-field image acquisition or for a display of an image, in regard to a limited region of interest comprising a target (e.g., target 190 of FIGURE 3 or FIGURE 5), wherein the apparatus is configured as a micro-electro-mechanical system (MEMS) (thin film optical system 140 or 140′ of FIGURES 2A-2D). The apparatus includes a light source (e.g., optical fiber 144 of FIGURE 2A), which emits light, a substrate (e.g., substrate 146 of FIGURE 2A) that serves as a support, and a cantilever comprising at least one of a thin film layer (e.g., thin film optical waveguide 150 of FIGURE 2B), and a thick film layer, and having a fixed end (e.g., fixed end 214 of FIGURE 3) and a free end (e.g., free end 216 of FIGURE 3). The fixed end remains fixed to the substrate upon which the cantilever was originally formed and the free end extends freely beyond where the substrate (e.g., substrate 220 of FIGURE 3) has been removed from supporting the cantilever, thus enabling the free end to bend and deflect relative to the substrate and the limited region of interest, for scanning with the free end of the cantilever relative to the target. The apparatus also includes an actuator (e.g., electrostatic actuator 156 of FIGURE 2A) disposed adjacent to the cantilever, the actuator being employed for bending and deflecting the cantilever so as to move the free end in a desired motion, to scan at least a portion of the limited region of interest. The apparatus further comprises a photon detector (e.g., photon detectors 224a and 224b of FIGURE 3) configured to receive light at a location that is proximate to the cantilever and to the support, and a position sensor (e.g., position sensor array 236 of FIGURE 3) employed for detecting (detects vertical and horizontal positions, see page 18, lines 22-23) a position of the free end of the cantilever, for producing a signal used in controlling the actuator to cause the cantilever to move in the desired motion.

Dependent Claim 27

Another aspect of the invention is directed to the cantilever that is formed by at least one of a deep reactive ion etching, a photolithography, an electron beam lithography, and a wet anisotropic etching of the substrate using a mask to define a shape of the cantilever (see page 23, lines 2-13 and the claims as filed).

Independent Claim 43

Another aspect of the invention is directed toward a method for enabling either a far-field

image acquisition or a display of an image, in regard to a limited region of interest, using a micro-electro-mechanical system (MEMS). The method comprises the steps of forming a cantilever on a substrate (e.g., spin coat SU-8 photoresist onto the silicon substrate, see page 22, lines 30-31) and removing a portion of the substrate (e.g., etching the silicon substrate down to near the fixed end to release the SU-8 cantilever, see page 23, lines 2-3) underlying the cantilever. Another step includes supporting the cantilever at a fixed end (e.g., fixed end 214 of FIGURE 3) of the cantilever, the fixed end remaining fixed to the substrate, and a free end (e.g., free end 216 of FIGURE 3) of the cantilever extending freely beyond where the portion of the substrate (e.g., substrate 220 of FIGURE 3) was removed from supporting the cantilever, thus enabling the free end to bend and deflect relative to a target in the limited region of interest, for scanning the target. Yet another step includes bending and deflecting (e.g., when driven into resonance, see page 18, line 9) the cantilever so as to move the free end in a desired motion to scan the target. The method includes the step of receiving light (e.g., using photon detectors 224a and 224b of FIGURE 3 that are integrated onto substrate 220, see page 18, lines 20-22) at a location that is proximate to the cantilever and to the support; and detecting a position (e.g., using position sensor array 236 of FIGURE 3),which detects vertical and horizontal position of free end, see page 18, lines 22-24) of the free end of the cantilever, producing a signal indicative of the position for use in controlling the cantilever (e.g., enables long term control of scanning stability, see page 18, lines 24-25) to move in the desired motion.

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GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

I. A determination as to whether Claims 1-5, 8, and 10-19 are patentable under 35 U.S.C. § 102(e) over U.S. Patent No. 6,485,413 (Boppart et al., hereinafter referred to as "Boppart").

II. A determination as to whether Claims 6 and 7 are patentable under 35 U.S.C. § 103(a) over Boppart in view of U.S. Patent No. 5,209,117 (Bennett).

III A determination as to whether Claims 20-24, 27-36, 38-40, 42-45, 47-56, and 58 are patentable under 35 U.S.C. § 103(a) over Boppart in view of U.S. Patent No. 6,563,998 (Farah); and Claims 25, 26, 41, 46, and 57 are patentable under 35 U.S.C. § 103(a) over Boppart in view of Farah and further in view of Bennett.

IV A determination as to whether Claims 8 and 27 are proper dependent claims.

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ARGUMENT

I. THE EXAMINER ERRED IN REJECTING CLAIMS 1-5, 8, and 10-19 UNDER 35 U.S.C. § 102(e) BECAUSE THE CITED ART FAILS TO TEACH ALL THAT THE CLAIMS RECITE.

It Is Appellants' Position That Claim 1 Is Patentable Under 35 U.S.C. § 102(e) Because The Cited Reference Fails To Teach A Cantilever That Is Configured EITHER As A Waveguide That **Conveys** Light From The Light Source **Within** The Cantilever OR As A Moving Carrier For The Light Source That Emits The Light, Wherein The Light Source Is Mounted On The Free End Of The Cantilever.

The cited art does not teach a *cantilever* that is configured EITHER as a waveguide that **conveys** light from the light source **within** the cantilever OR as a moving carrier for the light source that emits the light wherein the light source is mounted on the free end as recited in subparagraphs (c)(i) and (c)(ii) of independent Claim 1. The cited art does not read on this aspect of appellants' claims, because Boppart's cantilever is configured NEITHER as a waveguide that conveys light within it NOR as a moving carrier for a light source. Indeed, Boppart's cantilever does NOT transport or convey light at all, and it does NOT have a light source mounted on its free end. As illustrated in FIGURE 2, Boppart's light source 10 is located *external* to the probe module. Because Boppart is directed toward Optical Coherence Tomography (OCT), a modification to move the light source to the free end of the cantilever would render Boppart unsatisfactory for its intended purpose, since the resulting system could not be used for (OCT) with a light source in that location.

The Examiner has rejected Claims 1-5, 8, and 10-19 as being anticipated by Boppart (Page 3 in Office Action dated January 10, 2008). The Examiner has asserted that piezoelectric cantilever 74 described in column 11, lines 59-60 of Boppart is equivalent to appellants' cantilever. *Id.* The Examiner has also explained that cantilever 74 is one of a "waveguide" as pointed out in column 11, lines 60-61 since voltage is applied (in wave form) across the cantilever materials (see Page 2, Office Action dated January 10, 2008). The Examiner has also asserted that the optical fiber is attached to the cantilever (Figure 4c, elements 58 and 94) and that the cantilever serves as a waveguide (Page 4 in Office Action dated January 10, 2008). The Examiner asserts that "pivoting" can be interpreted as bending (Page 2 in Office Action dated January 10, 2008). Appellants respectfully disagree with this overly broad interpretation of Boppart's disclosure.

In order to illustrate the differences between Boppart and applicants' claims, it may be

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helpful to show examples of drawing elements from appellants' FIGURES, in regard to the recitation of subparagraphs (c), (c)(i) and (c)(ii) of independent Claim 1, as follows:

> a cantilever (e.g., cantilever 212 of FIGURE 4 or FIGURE 6B) comprising a fixed end (e.g., fixed end 214 of FIGURE 4) and a free end (e.g., free end 216 of FIGURE 4), the fixed end remaining fixed to the substrate (e.g., N-TYPE SUBSTRATE of FIGURE 4) and the free end extending freely relative to the substrate, enabling the free end to bend and deflect in regard to the limited region of interest, the bending of the cantilever scanning light onto an image plane to create an image, wherein the cantilever is configured as one of:
>
> > (i) a waveguide (e.g., cantilever 212 acts as waveguide, see page 19, line 3, or waveguides 242a and 242b of FIGURE 5) that conveys light from the light source (e.g., light source 205 of FIGURE 4) within the cantilever, when scanning the light onto the image plane to create the image; and
> >
> > (ii) a moving carrier (e.g., cantilever 212 for the light source, such as laser diode 272 of FIGURE 6B) that emits the light, the light source being mounted on the free end of the cantilever (e.g., free end 216 of FIGURE 6B) and moving when scanning the light emitted by the light source onto the image plane to create the image

The cantilever is recited in subparagraph (c)(i) as being configured as a waveguide. Appellants describe that cantilever 212 acts as a waveguide to scan the light for display (see appellants' specification, page 19, line 3 and FIGURE 4). The waveguide directs emitted light from a fixed end 214 to a free end 216 (specification, page 18, lines 3-4). In the alternative, in subparagraph (c)(ii), the cantilever is recited as being configured as a moving carrier that emits the light. In this configuration, the light source is mounted on the free end of the cantilever (see FIGURE 6B and specification, page 20, lines 26-27).

In contrast, piezoelectric cantilever 74 of Boppart's Figure 4b is NOT equivalent to either the waveguide recited in subparagraph (c)(i) OR the moving carrier recited in subparagraph (c)(ii). First, as shown in Boppart's Figure 4b, piezoelectric cantilever 74 is not a waveguide because it does NOT convey light from the light source *within* it. Instead, light is conveyed within Boppart's single-mode fiber 58, as shown in Figure 4b; however, single-mode fiber 58 is NOT the cantilever. The Examiner has also asserted that cantilever 74 is a waveguide because voltage is applied (being in wave form) across the cantilever materials. Appellants note that cantilever 74 is described by Boppart as being a *piezoelectric* cantilever 74. But subparagraph (c)(i) recites that light is conveyed ***within the cantilever***. Subparagraph (c)(i) does NOT recite that a voltage is conveyed within the

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cantilever. Second, in contrast to appellants' alternative recited in subparagraph (c)(ii), Boppart's cantilever 74 is NOT a moving carrier that emits the light, because there is NO light source mounted on the free end of cantilever 74. Instead, as clearly shown in Figure 4b, a GRIN lens is mounted on the free end of cantilever 74. A GRIN lens is NOT a light source. Although single-mode optical fiber 58 emits the light, once again, it is NOT configured as a cantilever, and even if it were configured as a cantilever, it does NOT have a light source mounted on its free end to emit light.

In addition, single mode optical fiber 58 and pivot point 94 of Boppart's Figure 4c are NOT the equivalent of the waveguide recited in subparagraph (c)(i) NOR the equivalent of the moving carrier recited in subparagraph (c)(ii) because Boppart fails to disclose any cantilever that is equivalent to the cantilever recited in appellants' subparagraph (c).

The Examiner has stated that Boppart's teaching of pivoting (the fiber/lens unit) about pivot point 94 (Boppart, column 12, lines 36-37) can be interpreted as bending. However, appellants respectfully disagree, since one of ordinary skill in the art would understand that the drawing and teaching in Boppart refers to pivoting the lens unit about the pivot point and not bending a flexible member. Also, a portion of subparagraph (c) recites a cantilever that comprises a fixed end and a free end, *the fixed end remaining fixed to the substrate*, and the free end extending freely relative to the substrate, enabling the free end to ***bend*** and deflect. If the Examiner is asserting that the lens unit that pivots about a pivot point is equivalent to the bending and deflecting cantilever recited by appellants, then it is not clear what portion of single mode optical fiber 58 remains fixed to the substrate in Figure 4c or, what portion of the single mode optical fiber corresponds to a free end of a cantilever that extends freely relative to the substrate and bends and deflects. As shown in Figure 4c, an end of single mode optical fiber 58 is NOT fixed to any substrate and no portion of the optical fiber bends and deflects relative to a substrate. Clearly, there is no cantilever in Figure 4c that corresponds to the language recited in the claim.

Appellants also point out that Figure 4b and Figure 4c represent two different embodiments in Boppart. The cantilever in Figure 4b does not convey light – instead, only the single mode optical fiber does; the single mode optical fiber in Figure 4c is not a cantilever. The Examiner is thus mixing these two embodiments together in order to reject Claim 1, but there is no reason why one of ordinary skill in the art would understand that the cantilever shown in Figure 4b of Boppart might convey light, since Boppart does not suggest such a cantilever. Because the embodiment of Figure 4c does not include a cantilever, it is NOT relevant to appellants' Claim 1 and should not be

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combined with the embodiment shown in Figure 4b. In addition, Boppart does not teach or suggest a moving light carrier, which is the other alternative recited in the claim. Accordingly, because the cited art fails to teach a cantilever that is configured as a waveguide, or as a moving light carrier, the rejection of this claim is improper.

<u>It Is Further Appellants' Position That Claim 1 Is Patentable Under 35 U.S.C. § 102(e) Because The Cited Reference Fails To Teach A Photon Detector That Receives Light At A Location Proximate To Both The Cantilever And To The Support.</u>

Subparagraph (e) of Claim 1 recites "a photon detector configured to receive light at a location that is proximate to the cantilever and to the support." The cited art does not teach an element equivalent to appellants' photon detector wherein the photon detector receives light at a location proximate to both the cantilever *and* to the support. Instead, Boppart teaches an element that receives light only at a location proximate to the cantilever – but not proximate to any support for the cantilever. The Examiner asserts that single mode optical fiber 58 of Figure 4b is equivalent to appellants' photon detector (Page 3 of Office Action dated January 10, 2008). The Examiner further explains that although appellants have argued previously (Office Action Response dated June 25, 2007, page 17, lines 16-19) that the photon detector is a separate element from the cantilever, appellants do not point out this limitation within the claim language (Page 2 of Office Action dated January 10, 2008). In addition, the Examiner explains that Boppart clearly teaches the aforementioned limitation wherein Figure 4b the two elements are present all within proximate distance to one another.

In order to illustrate the differences between Boppart and the recitation of appellants' claim, it may be helpful to show drawing elements from appellants' FIGURES, which serve as examples of portions of the recitation of subparagraph (e) of independent Claim 1, as follows:

> a photon detector (e.g., photon detectors 224a and 224b of FIGURE 3) configured to receive light at a location that is proximate to the cantilever (e.g., cantilever 212 of FIGURE 4 or FIGURE 6B) and to the support (e.g., N-TYPE SUBSTRATE of FIGURE 5);

Appellants disclose that a photon detector can be included for monitoring the displayed image and/or measuring motion of the cantilever scanner(s) (see page 12, lines 28-30 of appellants' specification). Also, in FIGURE 3, appellants illustrate photon detectors 224a and 224b that are integrated into substrate 220, to directly receive light at a location proximate to the substrate and

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cantilever. In an alternative approach shown in FIGURE 6A, appellants illustrate a flexible optical fiber 256 that directs the received light through a coupler 258 to an optional semiconductor waveguide 260, which directs the light to one or more photon detectors 262 disposed proximally. However, the light reflected from a target 190 is still received by flexible optical fiber 256 at a location that is proximate to the cantilever and substrate.

In contrast, Boppart's single mode optical fiber 58 is NOT equivalent to appellants' recited photon detector because it does not receive light at a location that is proximate to the cantilever 74 ***and*** to the support (or substrate). With respect to Boppart's Figure 4b, although not identified with an element number, it appears that there is some kind of support or substrate beneath piezoelectric cantilever 74. For Boppart's single mode optical fiber to be equivalent, it must receive light at a location that is proximate to cantilever 74 and to its support or substrate. Assuming that the end of the single mode optical fiber that is attached to the GRIN lens is configured to receive light, the end of the optical fiber is proximate cantilever 74, but is NOT proximate to the support for cantilever 74.

Furthermore, the Examiner stated that appellants have not pointed out the claim recitation indicating that the photon detector is a separate element from the cantilever (Office Action dated January 10, 2008, page 2). Appellants respectfully disagree because appellants' recited photon detector is a separate element from the cantilever. One of ordinary skill in this art would clearly understand that these two elements are separate based on subparagraph (e) of Claim 1, which recites "a photon detector …proximate to the *cantilever* and to the support." If one assumes that the photon detector is the same element as the cantilever, the claim recitation would essentially recite "a photon detector …proximate to itself and to the support," but this would be illogical and would not be supported by appellants' drawings or specification. Therefore, it is clear that subparagraph (e) recites a photon detector as a separate element of the apparatus from the cantilever. Accordingly, the cited art does not teach or suggest an element equivalent to appellants' photon detector that receives light at a location proximate to *both* the cantilever *and* to the support.

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II. THE EXAMINER ERRED IN REJECTING CLAIMS 6 and 7 UNDER 35 U.S.C. § 103(a) BECAUSE THESE CLAIMS DEPEND FROM INDEPENDENT CLAIM 1 THAT IS PATENTABLE.

<u>It Is Further Appellants' Position That Claims 6 And 7 Are Patentable Under 35 U.S.C. § 103(a) Because These Claims Are Dependent Claims That Depend From A Patentable Independent Claim.</u>

The Examiner rejected Claims 6 and 7 under 35 U.S.C. § 103(a) as being unpatentable over Boppart in view of Bennett.

Claims 6 and 7 depend from independent Claim 1. Since dependent claims inherently include all that is recited in the independent claim from which they ultimately depend, Claims 6 and 7 are patentable for at least the same reasons as noted above in regard to Claim 1.

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III. THE EXAMINER ERRED IN REJECTING CLAIMS 20-24, 27-36, 38-40, 42-45, 47-56, and 58 and Claims 25, 26, 41, 46, and 57 UNDER 35 U.S.C. § 103(a) BECAUSE A *PRIMA FACIE* CASE OF OBVIOUSNESS HAS NOT BEEN ESTABLISHED.

<u>It Is Appellants' Position That Claims 20-36 And 38-42 Are Patentable Under 35 U.S.C. § 103(a) Because A *Prima Facie* Case Of Obviousness Has Not Been Established Since There Is No Suggestion or Motivation To Modify The Cited References To Read on Independent Claim 20.</u>

Subparagraph (c) of independent Claim 20 recites "a cantilever comprising at least one of a thin film layer and a thick film layer and having a fixed end and a free end, the fixed end remaining fixed to the substrate upon which the cantilever was originally formed and the free end extending freely beyond where the substrate has been removed from supporting the cantilever, enabling the free end to bend and deflect relative to the substrate and the limited region of interest, for scanning with the free end of the cantilever relative to the target." Farah does not teach how a cantilever might be employed for bending and deflecting, for scanning relative to a target, as recited in subparagraph (c), when the apparatus is configured as a micro-electro-mechanical system (MEMS), as recited in the preamble of Claim 20.

The Examiner has rejected Claims 20-24, 27-36, 38-40, and 42 under 35 U.S.C. § 103(a) as being unpatentable over Boppart in view of Farah (Office Action dated January 10, 2008, page 5). The Examiner has rejected Claims 25, 26, and 41, under 35 U.S.C. § 103(a) as being unpatentable over Boppart in view of Farah and further in view of Bennett (Office Action dated January 10, 2008, page 7). But note that the Examiner's citations are to paragraph numbers of another Farah reference (U.S. Patent Publication No. 2004/0033006, hereinafter referred to as "Farah 2"). Both Farah and Farah 2 were cited on page 6 of an earlier Office Action response, dated August 1, 2006. The Examiner admits Boppart fails to disclose that the image acquisition system is configured as a micro-electro-mechanical system (MEMS) (Office Action dated January 10, 2008, page 7). However, the Examiner indicates that Farah discloses a system for an optical waveguide, as is used in the system of Boppart. *Id*. The Examiner further indicates Farah discloses that it is known in the art that optical waveguide devices are typically made on silicon substrates (Farah 2, paragraph 3), that these cantilevered film waveguides (Farah 2, paragraph 5) may be constructed as MEMS devices and fabricated in silicon wafers (Farah 2, paragraph 13), and that the MEMS structure includes a thick substrate and a thin piezoelectric layer, which constitute the thick and thin layers (Farah 2, paragraph 44). *Id.* The Examiner concludes that it would have been obvious to one of

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ordinary skill in the art at the time of the invention to modify the disclosure of Boppart in light of the disclosure of Farah, to configure the apparatus as a micro-electro-mechanical system, since the MEMS device allows a small structure (on the order of microns), which allows the device to be used in a variety of devices such as probes, endoscopes, and other minimally invasive devices. *Id.* Appellants respectfully disagree.

A portion of subparagraph (c) recites (with emphasis added): "…enabling the free end to bend and deflect relative to the substrate and the limited region of interest, *for scanning with the free end of the cantilever relative to the target*." In contrast, Farah does not teach scanning a free end of a silicon cantilever relative to the target, but instead teaches a different function. Farah teaches that optical waveguide devices are typically made on silicon substrates (Farah, column 1, lines 21-22), and that in certain applications, it is desired "to incline the end faces of cantilevered film waveguides relative to the axis of the waveguide, especially at air gaps between cantilevered and fixed waveguides" (Farah, column 1, lines 59-62). However, Farah does NOT teach or suggest the use of silicon cantilevers or cantilevers in any MEMS device for scanning light relative to a target and does NOT teach or suggest enabling the free end of a cantilever to "***bend and deflect relative to the substrate and the limited region of interest, for scanning with the free end of the cantilever relative to the target***." Instead, Farah discloses driving a MEMS cantilever for use in a Mach-Zehnder interferometer (Farah, column 13, lines 30-33), or in an interferometric accelerometer (Farah, column 13, lines 49-50), or in an optical switch (Farah 2, paragraph 0067) – all of which are entirely different functions for a MEMS waveguide device cantilever than the optical scanning function recited in appellants' claims. Accordingly, it is clear that a person of ordinary skill in the art would NOT be led to modify Boppart to include a MEMS cantilever, since Farah does not teach or suggest that a MEMS cantilever might be used for scanning light relative to a target. Only through hindsight, based upon the teaching of appellants' application, might it now appear that a MEMS cantilever could be employed in the apparatus disclosed by Boppart, since substantial modification would be required of the apparatus disclosed by Boppart to employ a MEMS cantilever, and Farah does not teach how a cantilever might be employed for bending and deflecting, for optical scanning relative to a target. Accordingly, a *prima facie* case of obviousness has not been established to justify the rejection of these claims, since there is no suggestion or motivation to modify the cited references as required to achieve what appellants recite in the claims.

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It Is Appellants' Position That Claims 20-36 And 38-42 Are Patentable Under 35 U.S.C. § 103(a) Because A *Prima Facie* Case Of Obviousness Has Not Been Established Since All Of The Details Recited In Independent Claim 20 Have Not Been Considered.

A *prima facie* case of obviousness has not been established because the claim recitation of a photon detector, as recited in independent Claim 20, subparagraph (e) has not been considered when justifying the rejection. Thus, even if the cited references were combined, the element of a photon detector is not taught by any of the references cited. Subparagraph (e) recites (emphasis added): "a photon detector configured to receive light at a location that is **proximate** to the cantilever **and** to the support."

The Examiner asserts that imaging in Boppart may be carried out using a variety of embodiments, including photon imaging systems (citing to column 4, line 43) (Office Action dated January 10, 2008). Appellants respectfully disagree, because Boppart does NOT include any further discussion on what elements are present in a photon imaging system. With respect to Claim 20, the Examiner maintains on page 2 of the Office Action dated January 10, 2008 that Boppart teaches a photon detector like that recited in subparagraph (e) of Claim 20. However, Boppart's single mode optical fiber 58 of Figure 4b is NOT equivalent to a photon detector because it does not receive light at a location that is proximate to the cantilever 74 ***and*** to the support or substrate. Accordingly, a *prima facie* case of obviousness has not been established to justify the rejection of these claims, because the cited art does not teach or suggest a photon detector like that recited in the claim.

It Is Appellants' Position That Claims 43-58 Are Patentable Under 35 U.S.C. § 103(a) Because A *Prima Facie* Case Of Obviousness Has Not Been Established Since There Is No Suggestion or Motivation To Modify The Cited References To Read On Independent Claim 43.

More specifically, Farah does not teach how a cantilever might be bent and deflected, relative to a target, as recited in step (c), using a micro-electro-mechanical system (MEMS), as recited in the preamble. The Examiner has rejected Claims 43-45, 47-56 and 58 under 35 U.S.C. § 103(a) as being unpatentable over Boppart in view of Farah (Office Action dated January 10, 2008, page 5). Claims 46 and 57 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Boppart in view of Farah and further in view of Bennett (Office Action dated January 10, 2008, page 7). Again, it is noted that the Examiner's citations as set forth below are to paragraph numbers of Farah 2. The Examiner admits that Boppart fails to disclose that the image acquisition system is configured as a micro-electro-mechanical system (MEMS) (Office Action dated January 10, 2008, page 7).

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However, the Examiner indicates that Farah discloses a system for an optical waveguide, like that used in the system of Boppart. *Id.* The Examiner further asserts that Farah discloses it is known in the art that the optical waveguide devices are typically made on silicon substrates (Farah 2, paragraph 3), that these cantilevered film waveguides (Farah 2, paragraph 5) may be constructed as MEMS devices and fabricated in silicon wafers (Farah 2, paragraph 13), and that the MEMS structure includes a thick substrate and a thin piezoelectric layer, which constitute the thick and thin layers (Farah 2, paragraph 44). *Id.* The Examiner concludes that it would have been obvious to one of ordinary skill in the art at the time of the invention to modify the disclosure of Boppart in light of the disclosure of Farah to configure the apparatus as a micro-electro-mechanical system, because a MEMS device allows a small structure (on the order of microns), which allows the device to be used in a variety of devices such as probes, endoscopes, and other minimally invasive devices. *Id.* Appellants respectfully disagree.

A portion of step (c) recites (with emphasis added):

> supporting the cantilever at a fixed end of the cantilever…a free end of the cantilever extending freely beyond where the portion of the substrate was removed from supporting the cantilever, *enabling the free end to bend and deflect relative to a target in the limited region of interest,* for scanning the target

In contrast, Farah does not teach scanning a free end of a cantilever relative to the target, using a micro-electro-mechanical system, but instead teaches a different function. Farah teaches that optical waveguide devices are typically made on silicon substrates (Farah, column 1, lines 21-22). Farah further teaches that in certain applications, it is desired "to incline the end faces of cantilevered film waveguides relative to the axis of the waveguide, especially at air gaps between cantilevered and fixed waveguides" (Farah, column 1, lines 59-62). But, as noted above Farah does NOT teach or suggest the use of cantilevers, or cantilevers in any MEMS device for scanning light relative to a target and does NOT teach or suggest enabling the free end of a cantilever to "***bend and deflect relative to a target in the limited region of interest.***" Instead, Farah teaches driving a cantilever for use in a Mach-Zehnder interferometer (Farah, column 13, lines 30-33), or in an interferometric accelerometer (Farah, column 13, lines 49-50), or in an optical switch (Farah 2, paragraph 0067) – all of which are entirely different functions for a MEMS waveguide device cantilever than the optical scanning function recited in appellants' claims. Accordingly, it is clear that a person of ordinary skill in the art would NOT be led to modify Boppart to include a MEMS

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cantilever, since Farah does not teach or suggest that a MEMS cantilever might be used for scanning relative to a target. Only through hindsight, based upon the teaching of appellants' application, might it now appear that a MEMS cantilever could be employed in the apparatus disclosed by Boppart, since substantial modification would be required of the Boppart apparatus to employ a MEMS cantilever, and since Farah does not teach how a cantilever might be employed for bending and deflecting, for scanning relative to a target. Accordingly, a *prima facie* case of obviousness has not been established because there is no suggestion or motivation to modify the cited references.

It Is Appellants' Position That Claims 43-58 Are Patentable Under 35 U.S.C. § 103(a) Because A *Prima Facie* Case Of Obviousness Has Not Been Established Since All Of The Details Recited In Independent Claim 43 Have Not Been Considered.

This rejection is not justified, because the step of receiving light has not been considered, as recited in step (e) of independent Claim 43. More specifically, even if the cited references are combined, the step of receiving light at a location that is proximate to the cantilever and to the support element is NOT taught or suggested by Boppart or any other reference. Step (e) of Claim 43 recites (emphasis added): "receiving light at a location that is proximate to the cantilever **and** to the support."

The Examiner asserts that Boppart discloses a variety of embodiments, including photon imaging systems (column 4, line 43) (Office Action dated January 10, 2008). Appellants respectfully disagree because Boppart does NOT include details about a photon imaging system that performs a step that is equivalent to appellants' step (e). With respect to Claim 43, the Examiner maintains that Boppart teaches a photon detector of subparagraph (e) on page 2 of the Office Action dated January 10, 2008. However, Boppart's single mode optical fiber 58 of Figure 4b that receives light does NOT carry out a step that is equivalent to appellants' step of receiving light because the single mode optical fiber does not receive light at a location that is proximate to cantilever 74 ***and*** to the support or substrate. Accordingly, the cited art does not teach or suggest the step of receiving light at a location that is proximate to both a cantilever and a support, and the rejection of the claims is not justified.

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IV. THE EXAMINER ERRED IN REJECTING CLAIMS 8 AND 27 UNDER 35 U.S.C. § 103(a) BECAUSE THESE CLAIMS ARE PROPER DEPENDENT CLAIMS.

It Is Further Appellants' Position That Claims 8 and 27 Are Patentable Under 35 U.S.C. § 103(a) Because They Add Further Details To Independent Apparatus Claims 1 And 20, In Reciting How The Cantilever Is Formed.

Claims 8 and 27 generally recite:

> …wherein the cantilever is formed by at least one of a deep reactive ion etching, a photolithography, an electron beam lithography, and a wet anisotropic etching of the substrate using a mask to define a shape of the cantilever.

Although Claims 8 and 27 are apparatus claims, one of ordinary skill will appreciate that there are numerous approaches in which cantilevers might be formed, such as by reactive ion etching, photolithography, etc. Each of these ways of forming cantilevers inherently affects the resulting characteristics of a cantilever. Thus, a cantilever formed, for example, by electron beam lithography, will inherently have properties that differ from the properties of a cantilever formed by reactive ion etching, as will be appreciated by one of ordinary skill in the art.

The Examiner has indicated that Claims 8 and 27 are merely product by process claims and that the process by which by the cantilever is formed does not add any limitation to the structure of the cantilever itself. (Office Action, pages 4 and 7, dated January 10, 2008). In addition, the Examiner asserts that regardless of the inherent differing properties of a cantilever formed by any of these different techniques, the claims still recite a product by process (Office Action, dated January 10, 2008, page 3). Appellants respectfully disagree.

Appellants respectfully submit that each of these dependent claims further narrow the claim from which they respectively depend by reciting how the cantilever may be formed, because each different approach that is recited results in a cantilever with at least some different inherent properties. Thus, the cantilevers as further defined by Claims 8 and 27 are narrower than the cantilevers of Claims 1 and 20 and the dependent claims are proper. Accordingly, Claims 8 and 27 are patentable.

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CONCLUSION

The Examiner erroneously rejected Claims 1-5, 8, and 10-19 under 35 U.S.C. §102(e) in view of Boppart, because Boppart does not teach the recitation in independent Claim 1 of a cantilever that is configured as either a waveguide that **conveys** light from the light source **within** the cantilever or a moving carrier for the light source that emits the light, wherein the light source is mounted on the free end. Boppart also does not teach a photon detector that receives light at a location proximate to both the cantilever and to the support.

The Examiner erroneously rejected Claims 6 and 7 under 35 U.S.C. §103(a) as being unpatentable over Boppart and in view of Bennett because Claims 6 and 7 depend from independent Claim 1 that is patentable and these dependent claims are also patentable for at least the same reasons.

The Examiner erroneously rejected Claims 20-24, 27-36, 38-40, and 42 under 35 U.S.C. § 103(a) as being unpatentable over Boppart in view of Farah, and Claims 25, 26, and 41, under 35 U.S.C. § 103(a) as being unpatentable over Boppart in view of Farah and further in view of Bennett because there is no suggestion or motivation to modify the cited references to read on independent Claim 20. Farah does not teach how a cantilever might be employed for bending and deflecting, for optically scanning relative to a target, as recited in subparagraph (c), in regard to apparatus configured as a micro-electro-mechanical system (MEMS), as recited in the preamble.

The Examiner erroneously rejected Claims 20-24, 27-36, 38-40, and 42 under 35 U.S.C. § 103(a) as being unpatentable over Boppart in view of Farah, and Claims 25, 26, and 41, under 35 U.S.C. § 103(a) as being unpatentable over Boppart in view of Farah and further in view of Bennett because the photon detector as recited in subparagraph (e), independent Claim 20 is not taught or suggested by the prior art.

The Examiner erroneously rejected Claims 43-45, 47-56 and 58 under 35 U.S.C. § 103(a) as being unpatentable over Boppart in view of Farah, and Claims 46 and 57 under 35 U.S.C. § 103(a) as being unpatentable over Boppart in view of Farah and further in view of Bennett, because Farah does not teach the step of employing a cantilever that is bent and deflected, relative to a target, as recited in step (c), and in regard to a micro-electro-mechanical system (MEMS), as recited in the preamble of independent Claim 43. Neither reference teaches the step of receiving light at a location that is proximate to both the cantilever and the support.

The Examiner erroneously rejected Claims 8 and 27 as being an improper dependent claims,

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asserting that Claims 8 and 27 are product by process claims. Yet, these claims, which define how the cantilever is formed, are proper dependent claims, because the different techniques for forming a cantilever that are recited therein produce cantilevers with different inherent properties.

Appellants therefore respectfully request that the Board of Patent Appeals and Interferences overrule the Examiner's rejection of the claims and require that the Examiner pass this case to issue without further delay.

Respectfully submitted,

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<u>CLAIMS APPENDIX</u>

<u>Claims on Appeal</u>:

1. Apparatus for display of an image, in regard to a limited region of interest, comprising:

(a) a light source which emits light;

(b) a substrate that serves as a support;

(c) a cantilever comprising a fixed end and a free end, the fixed end remaining fixed to the substrate and the free end extending freely relative to the substrate, enabling the free end to bend and deflect in regard to the limited region of interest, the bending of the cantilever scanning light onto an image plane to create an image, wherein the cantilever is configured as one of:

(i) a waveguide that conveys light from the light source within the cantilever, when scanning the light onto the image plane to create the image; and

(ii) a moving carrier for the light source that emits the light, the light source being mounted on the free end of the cantilever and moving when scanning the light emitted by the light source onto the image plane to create the image;

(d) an actuator disposed adjacent to the cantilever and being employed for deflecting the cantilever so as to move the free end to scan in a desired motion;

(e) a photon detector configured to receive light at a location that is proximate to the cantilever and to the support; and

(f) a position sensor employed for detecting a position of the free end of the cantilever, for producing a signal used in controlling the actuator to cause the cantilever to move in the desired motion.

2. The apparatus of Claim 1, wherein the apparatus has at least two dimensions smaller than three millimeters.

3. The apparatus of Claim 1, wherein the light source provides the light using at least one of a diode, a laser, and an optical fiber.

4. The apparatus of Claim 1, wherein the light source is one of:

(a) end-butted to the fixed end of the cantilever; and

(b) attached adjacent to the free end of the cantilever.

5. The apparatus of Claim 1, wherein the cantilever comprises at least one of a silicon oxide, a silicon nitride, a glass, a polymer, a photoresist, and an epoxy resin.

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6. The apparatus of Claim 1, wherein the cantilever is tapered in at least one dimension such that the fixed end is larger than the free end in said at least one dimension.

7. The apparatus of Claim 1, wherein a dimension of the cantilever varies from the fixed end to the free end to determine vibrational characteristics of the cantilever.

8. The apparatus of Claim 1, wherein the cantilever is formed by at least one of a deep reactive ion etching, a photolithography, an e-beam lithography and a wet anisotropic etching of the substrate using a mask to define a shape of the cantilever.

9. (Canceled)

10. The apparatus of Claim 1, wherein the cantilever is one of:

(a) deflected into a resonant motion in at least one of two directions;

(b) deflected into a non-resonant motion in at least one of the two directions;

(c) deflected into two-dimensional circular motion using a single actuator;

(d) deflected into two-dimensional rocking linear motion using single actuator; and

(e) deflected so as to selectively move the free end to a desired position.

11. The apparatus of Claim 1, wherein the actuator comprises one of an electrostatic force actuator, a piezoelectric actuator, and an electromagnetic actuator.

12. The apparatus of Claim 1, wherein the actuator comprises at least one of:

(a) an actuator for deflecting the cantilever in a vertical direction relative to a primary plane of the substrate; and

(b) an actuator for deflecting the cantilever in a horizontal direction relative to the primary plane of the substrate.

13. The apparatus of Claim 1, wherein the actuator is attached to at least one of:

(a) the cantilever; and

(b) the substrate.

14. The apparatus of Claim 1, wherein the position sensor comprises one of:

(a) the actuator;

(b) a piezoelectric transducer;

(c) a capacitive displacement transducer;

(d) a piezoresistive sensor;

(e) a light source and detector pair;

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(f) a photodetector array;

(g) a magnetic sensor;

(h) a fiber bundle displacement sensor;

(i) an interferometer; and

(j) an inductive displacement transducer.

15. The apparatus of Claim 1, further comprising a lens disposed at the free end of the cantilever through which the light conveyed through the cantilever passes.

16. The apparatus of Claim 15, wherein the lens comprises one of a focusing lens, a refractive lens, and a diffractive lens.

17. The apparatus of Claim 15, wherein the free end of the cantilever comprises a gradient index lens.

18. The apparatus of Claim 1, wherein the light source comprises:

(a) a white light source; and

(b) a tunable color filter to provide precise color spectrum of light, the tunable color filter comprising one of:

(i) an optical resonant cavity;

(ii) a grating; and

(iii) a prism.

19. The apparatus of Claim 1, wherein the light source comprises a plurality of color elements, each of the plurality of color elements producing a different color light.

20. Apparatus for use either for a far-field image acquisition or for a display of an image, in regard to a limited region of interest comprising a target, wherein the apparatus is configured as a micro-electro-mechanical system (MEMS), the apparatus comprising:

(a) a light source, which emits light;

(b) a substrate that serves as a support;

(c) a cantilever comprising at least one of a thin film layer and a thick film layer and having a fixed end and a free end, the fixed end remaining fixed to the substrate upon which the cantilever was originally formed and the free end extending freely beyond where the substrate has been removed from supporting the cantilever, enabling the free end to bend and deflect relative to the substrate and the limited region of interest, for scanning with the free end of the cantilever relative to the target;

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(d) an actuator disposed adjacent to the cantilever, the actuator being employed for bending and deflecting the cantilever so as to move the free end in a desired motion, to scan at least a portion of the limited region of interest;

(e) a photon detector configured to receive light at a location that is proximate to the cantilever and to the support; and

(f) a position sensor employed for detecting a position of the free end of the cantilever, for producing a signal used in controlling the actuator to cause the cantilever to move in the desired motion.

21. The apparatus of Claim 20, wherein the apparatus has at least two dimensions smaller than three millimeters.

22. The apparatus of Claim 20, wherein the light source provides the light using at least one of a diode, a laser, and an optical fiber.

23. The apparatus of Claim 20, wherein the light source is one of:

(a) end-butted to the fixed end of the cantilever; and

(b) attached adjacent to the free end of the cantilever.

24. The apparatus of Claim 20, wherein the cantilever comprises at least one of a silicon oxide, a silicon nitride, a glass, a polymer, a photoresist, and an epoxy resin.

25. The apparatus of Claim 20, wherein the cantilever is tapered in at least one dimension such that the fixed end is larger than the free end in said at least one dimension.

26. The apparatus of Claim 20, wherein a dimension of the cantilever varies from the fixed end to the free end to determine vibrational characteristics of the cantilever.

27. The apparatus of Claim 20, wherein the cantilever is formed by at least one of a deep reactive ion etching, a photolithography, an electron beam lithography, and a wet anisotropic etching of the substrate using a mask to define a shape of the cantilever.

28. The apparatus of Claim 20, wherein the cantilever comprises one of:

(a) an emitting waveguide that receives the light at the fixed end and directs the light received to the free end, where the light is emitted for illuminating the target;

(b) a receiving waveguide that receives light that is reflected from the target through the free end and directs the received light to the fixed end for detection by the photon detector; and

(c) a flexible member that supports the light source.

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29. The apparatus of Claim 20, wherein the cantilever is one of:

(a) deflected into a resonant motion in at least one of two directions;

(b) deflected into a non-resonant motion in at least one of the two directions;

(c) deflected into two-dimensional circular motion using single actuator;

(d) deflected into two-dimensional rocking linear motion using single actuator; and

(e) deflected so as to selectively move the free end to a desired position.

30. The apparatus of Claim 20, wherein the actuator comprises one of an electrostatic force actuator, a piezoelectric actuator, and a magnetic actuator.

31. The apparatus of Claim 20, wherein the actuator comprises at least one of:

(a) an actuator for deflecting the cantilever in a vertical direction relative to a primary plane of the substrate; and

(b) an actuator for deflecting the cantilever in a horizontal direction relative to the primary plane of the substrate.

32. The apparatus of Claim 20, wherein the actuator is attached to at least one of:

(a) the cantilever; and

(b) the substrate.

33. The apparatus of Claim 20, wherein the position sensor comprises one of:

(a) the actuator;

(b) a piezoelectric transducer;

(c) a capacitive displacement transducer;

(d) a piezoresistive sensor;

(e) a light source and detector pair;

(f) a photodetector array;

(g) a magnetic sensor;

(h) a fiber bundle displacement sensor;

(i) an interferometer; and

(j) an inductive displacement transducer.

34. The apparatus of Claim 20, further comprising a lens disposed at the free end of the cantilever through which the light conveyed through the cantilever passes.

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35. The apparatus of Claim 34, wherein the lens comprises one of a focusing lens, a refractive lens, and a diffractive lens.

36. The apparatus of Claim 34, wherein the free end of the cantilever comprises a gradient index lens.

37. (Canceled)

38. The apparatus of Claim 20, wherein the photon detector is supported by one of the substrate and the cantilever.

39. The apparatus of Claim 20, wherein the photon detector is disposed at one of:

(a) adjacent to the free end of the cantilever, to detect light emitted from the free end of the cantilever that has been reflected from the target;

(b) adjacent to the fixed end of the cantilever, to detect light that has been received from the target at the free end of the cantilever and conveyed to the fixed end of the cantilever; and

(c) on the free end of the cantilever, to detect light emitted from the free end of the cantilever that has been reflected from the target.

40. The apparatus of Claim 20, further comprising a controller that causes the actuator to drive the free end of the cantilever in a pattern relative to the target, so as to do one of:

(a) display an image on the target; and

(b) acquire an image of the target.

41. The apparatus of Claim 20, further comprising at least one of:

(a) a tapered waveguide coupler optically coupling the light source to the cantilever; and

(b) an index-matching material optically coupling the light source to the cantilever.

42. The apparatus of Claim 20, further comprising a flexible sheath enclosing the light source, substrate, cantilever, actuator, and position sensor, so that the apparatus is usable as an endoscope.

43. A method for enabling either a far-field image acquisition or a display of an image, in regard to a limited region of interest, using a micro-electro-mechanical system (MEMS), comprising the steps of:

(a) forming a cantilever on a substrate;

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(b) removing a portion of the substrate underlying the cantilever;

(c) supporting the cantilever at a fixed end of the cantilever, the fixed end remaining fixed to the substrate, a free end of the cantilever extending freely beyond where the portion of the substrate was removed from supporting the cantilever, enabling the free end to bend and deflect relative to a target in the limited region of interest, for scanning the target;

(d) bending and deflecting the cantilever so as to move the free end in a desired motion to scan the target;

(e) receiving light at a location that is proximate to the cantilever and to the support; and

(f) detecting a position of the free end of the cantilever, producing a signal indicative of the position for use in controlling the cantilever to move in the desired motion.

44. (Original) The method of Claim 43, wherein the cantilever has at least two dimensions that are smaller than one millimeter.

45. The method of Claim 43, further comprising one of the steps of:

(a) end-butting a light source to the fixed end of the cantilever; and

(b) attaching a light source adjacent to the free end of the cantilever.

46. The method of Claim 43, further comprising the step of tapering the cantilever in at least one dimension, such that the fixed end is larger than the free end in said at least one dimension.

47. The method of Claim 43, further comprising the step of forming the cantilever by at least one of a deep reactive ion etching and a wet anisotropic etching of the substrate using a mask to define a shape of the cantilever.

48. The method of Claim 43, further comprising at least one of the steps of:

(a) receiving light at the fixed end and directing the light received to the free end, said cantilever acting as a waveguide, said free end emitting light to illuminate the target;

(b) receiving light that is reflected from the target through the free end and directing the light that is received to the fixed end for detection by a photon detector; and

(c) supporting a light source at the free end, said light source emitting light that illuminates the target.

49. The method of Claim 43, wherein the step of deflecting comprises one of the steps of:

(a) deflecting the cantilever into a resonant motion in at least one of two orthogonal directions; and

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(b) deflecting the cantilever so as to selectively move the free end to a desired position.

50. (Original) The method of Claim 43, where the step of deflecting comprises at least one of the steps of:

(a) deflecting the cantilever in a vertical direction relative to a primary plane of the substrate; and

(b) deflecting the cantilever in a horizontal direction relative to the primary plane of the substrate.

51. The method of Claim 43, wherein the step of sensing the position of the cantilever is done with one of:

(a) an actuator, when the actuator is not being employed for driving the cantilever to move in the desired motion;

(b) a piezoelectric transducer;

(c) a capacitive displacement transducer;

(d) a piezoresistive sensor;

(e) a light source and detector pair;

(e) a photodetector array;

(f) a magnetic sensor;

(g) a fiber bundle displacement sensor;

(h) an interferometer; and

(j) an inductive displacement transducer.

52. The method of Claim 43, further comprising the step of focusing light transmitted through the free end of the cantilever.

53. The method of Claim 52, wherein the step of focusing light is done with one of:

(a) a refractive lens;

(b) a diffractive lens; and

(c) a gradient index lens formed at the free end of the cantilever.

54. The method of Claim 43, further comprising the step of detecting light that is reflected from the target.

55. The method of Claim 54, wherein the step of detecting the light is carried out with one of:

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(a) a light sensor that is disposed adjacent to the free end of the cantilever, to detect light emitted from the free end of the cantilever that is reflected from the target; and

(b) a light sensor that is disposed adjacent to the fixed end of the cantilever, to detect light that has been received from the target at the free end of the cantilever and conveyed to the fixed end of the cantilever.

56. The method of Claim 43, wherein the step of deflecting the cantilever comprises the step of driving the free end of the cantilever to move in a pattern relative to the target so as to do one of the steps of:

(a) displaying an image on the target; and

(b) acquiring an image of the target.

57. The method of Claim 43, further comprising at least one of the steps of:

(a) coupling a light source to the fixed end of the cantilever through a tapered waveguide coupler; and

(b) coupling a light source to the fixed end of the cantilever with an index-matching material.

58. The method of Claim 43, further comprising the step of enclosing at least the substrate and the cantilever in a flexible sheath to function as an endoscope.

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EVIDENCE APPENDIX

Appendix Listing

None

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RELATED PROCEEDINGS APPENDIX

Appendix Listing

None

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